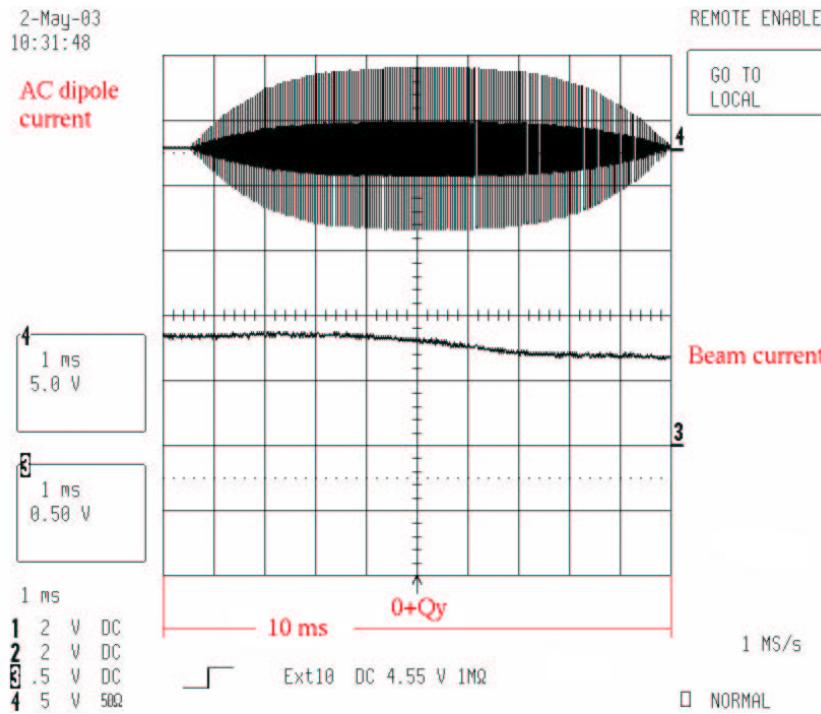


Status and Commissioning Plans of AGS Cold Snake

Waldo MacKay

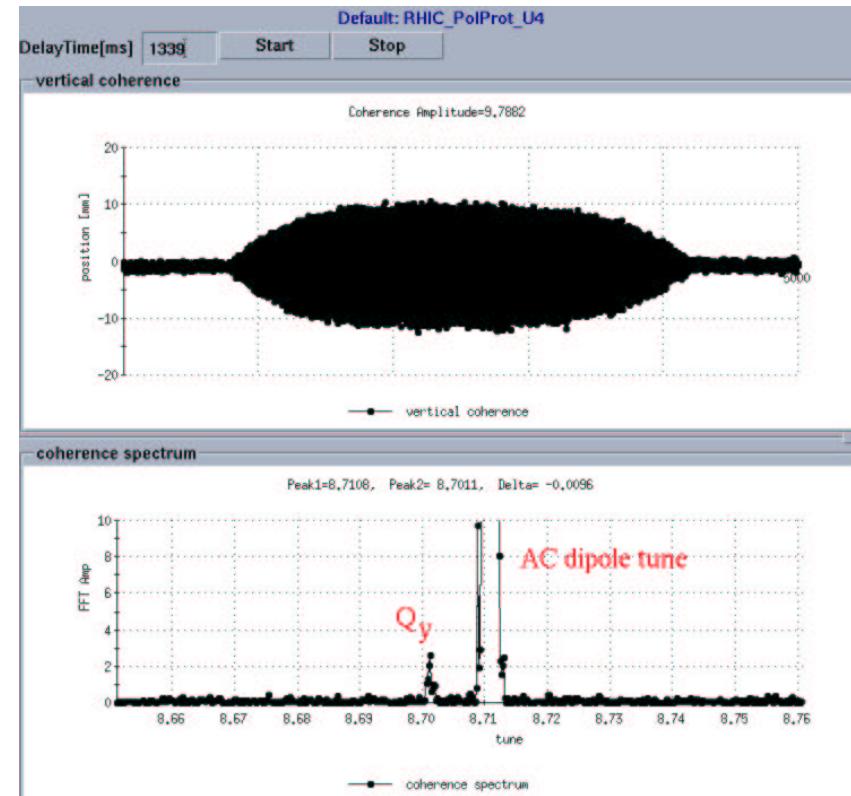


⚡ AC Dipole pulse at $G\gamma = 0 + Q_y$ ⚡



Top: AC dipole pulse amplitude
(current)

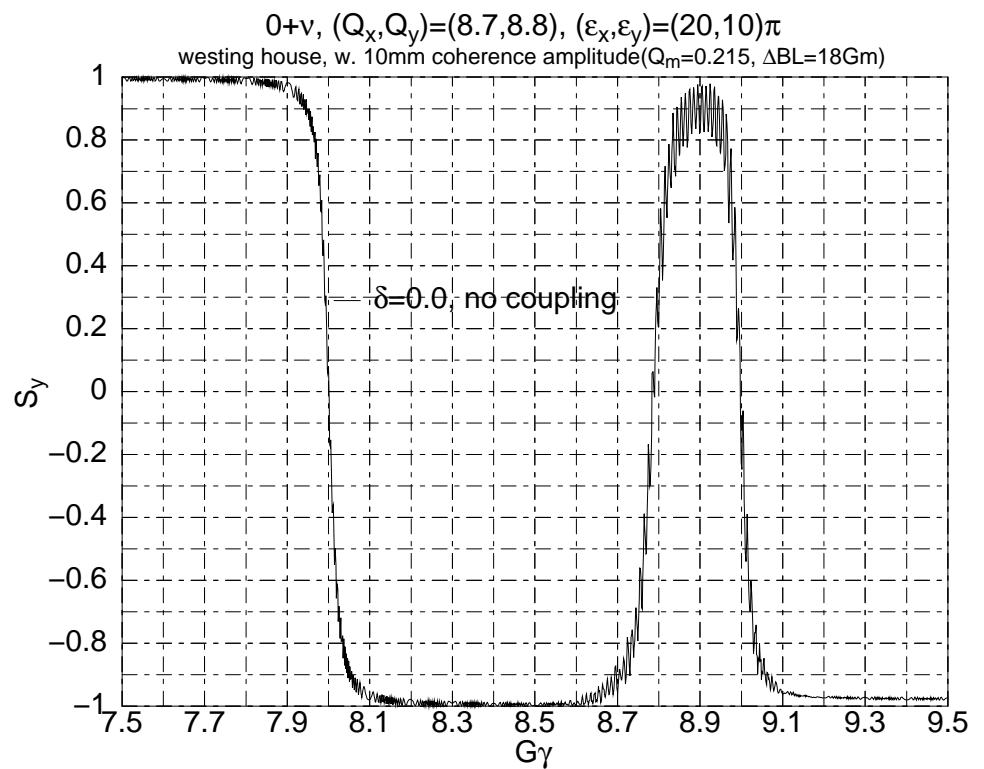
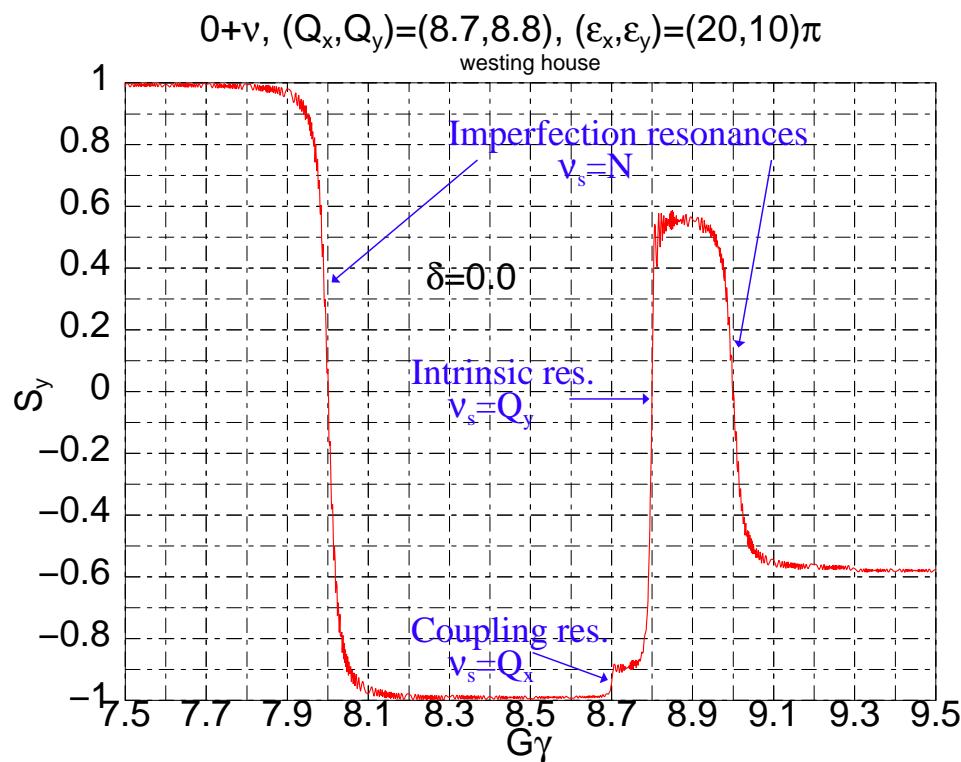
Bottom: Beam current.
(Just scrapes the beam pipe.)



Top: Beam coherence

Bottom: Tune spectrum

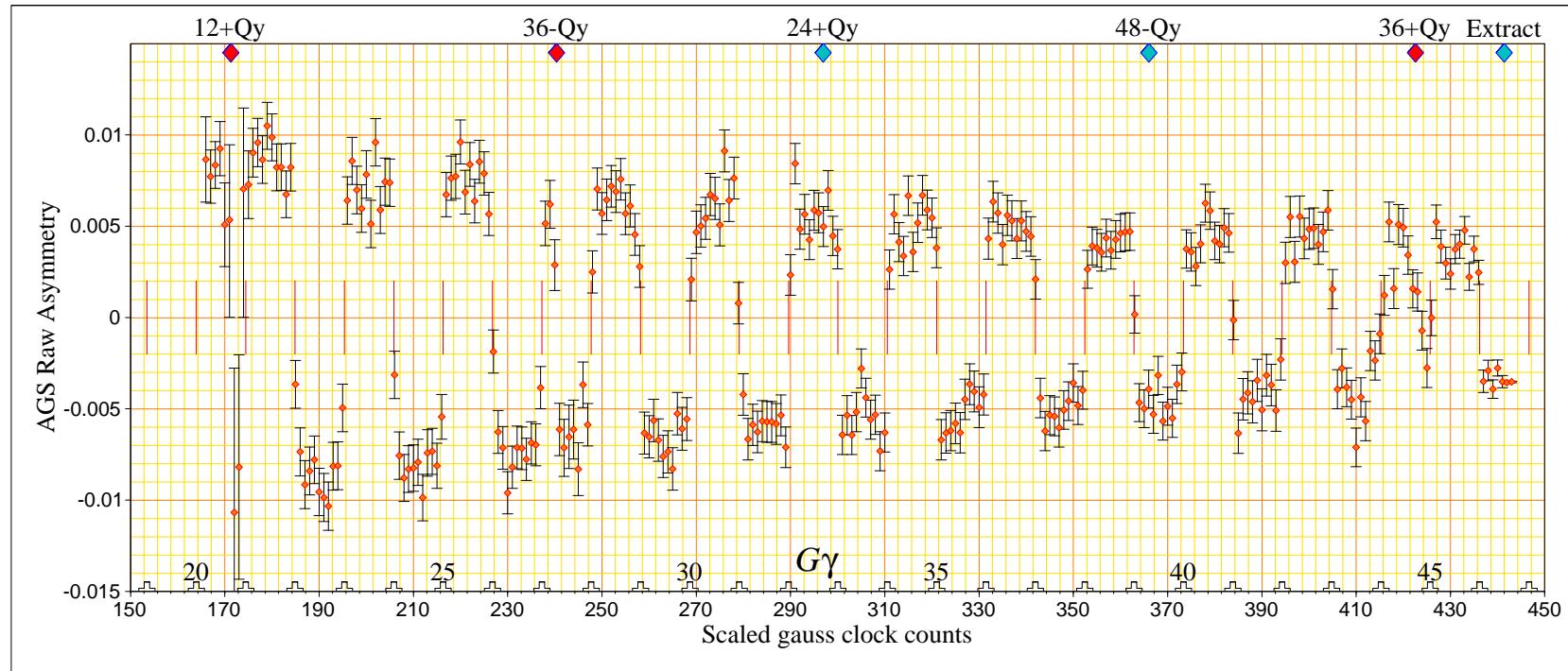
Resonance Crossing in AGS



AC dipole used to increase strength
of $v_s = Q_y$ resonance.

(Simulations by Mei Bai)

↳ AGS Raw Asymmetry during Ramp ↳



AGS has 12 superperiods.
 Vertical betatron tune: 8.7
 Snake strength: 5%
 (From Jeff Woods)

AC dipole pulses at resonances:

- $0 + Q_y$
- $12 + Q_y$
- $36 - Q_y$
- $36 + Q_y$

♪ Partial Snake in AGS ♪

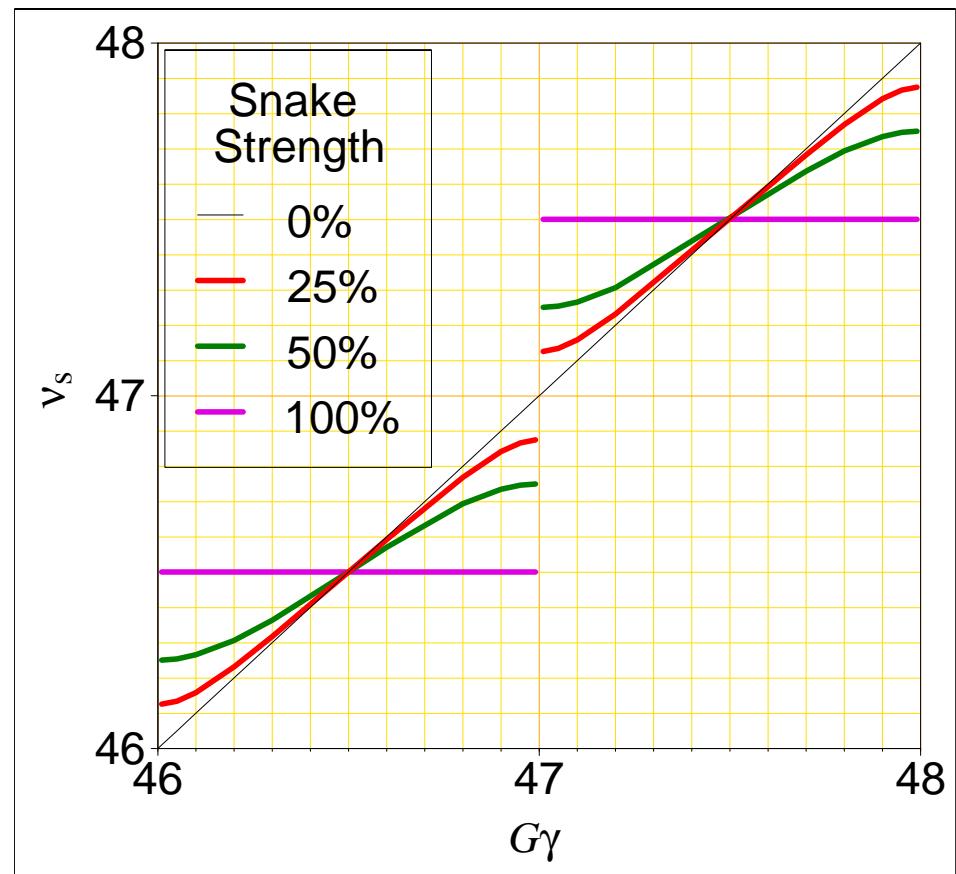
Adding a partial snake opens up stop bands around the integer imperfection resonances.

At the snake the stable spin direction points along the snake's rotation axis when $G\gamma = \text{integer}$.

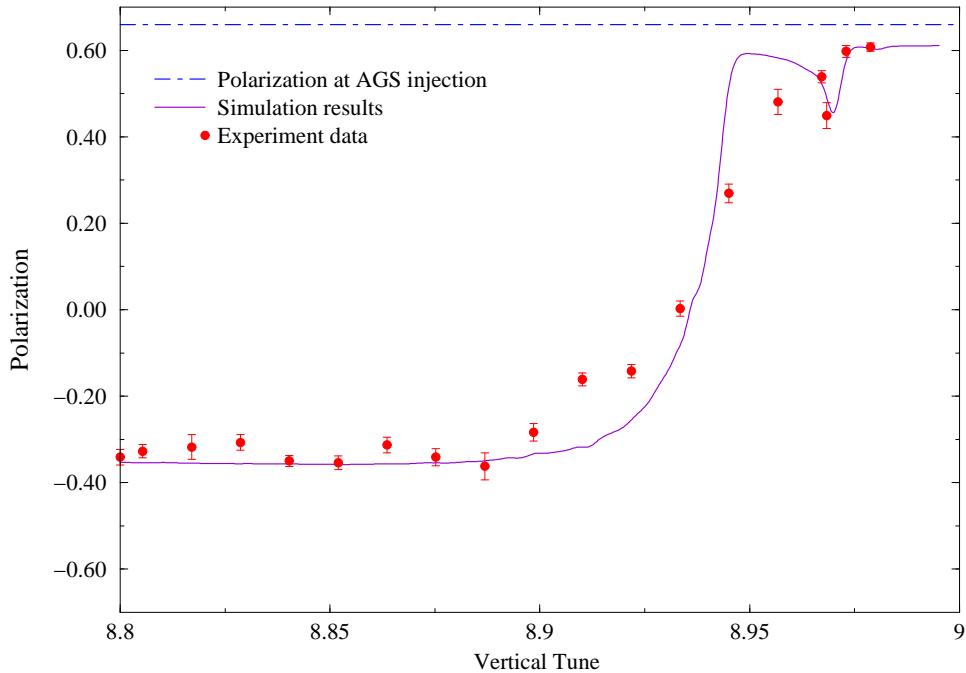
Partial snake strength: $\frac{\mu}{\pi}$

$$\cos \pi\nu_s = \cos(G\gamma\pi) \cos \frac{\mu}{2}$$

μ is the rotation angle the snake.



⌚ Crossing $0+Q_y$ with 10% snake ⌚



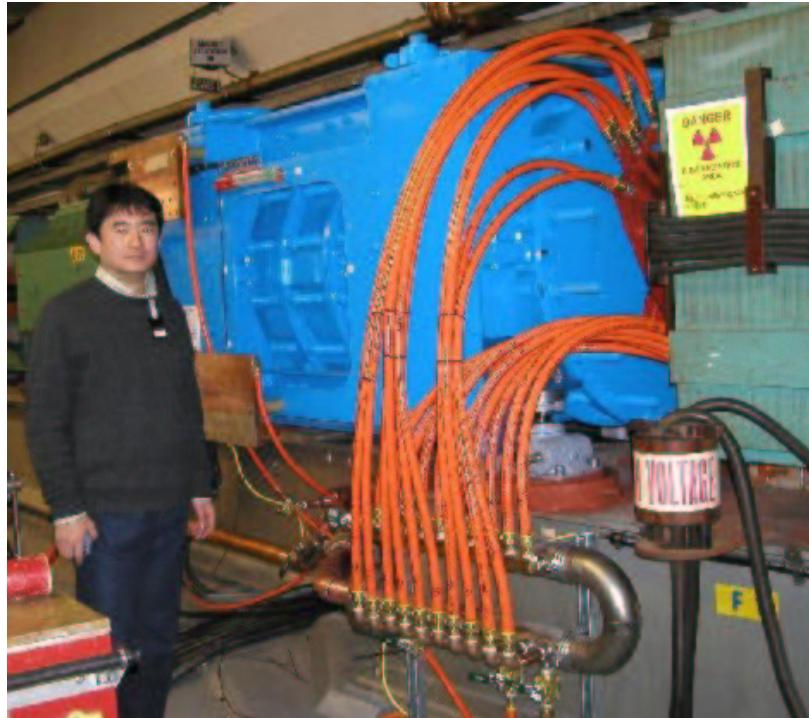
The old solenoidal snake was used.

The difference between the red measurements and the blue line is due to a coupling resonance and tilted stable spin direction.

This shows good agreement with the model.

Huang et al., Phys. Rev. ST-AB 7, 071001 (2004).

♪ New Warm Helical Snake ♪

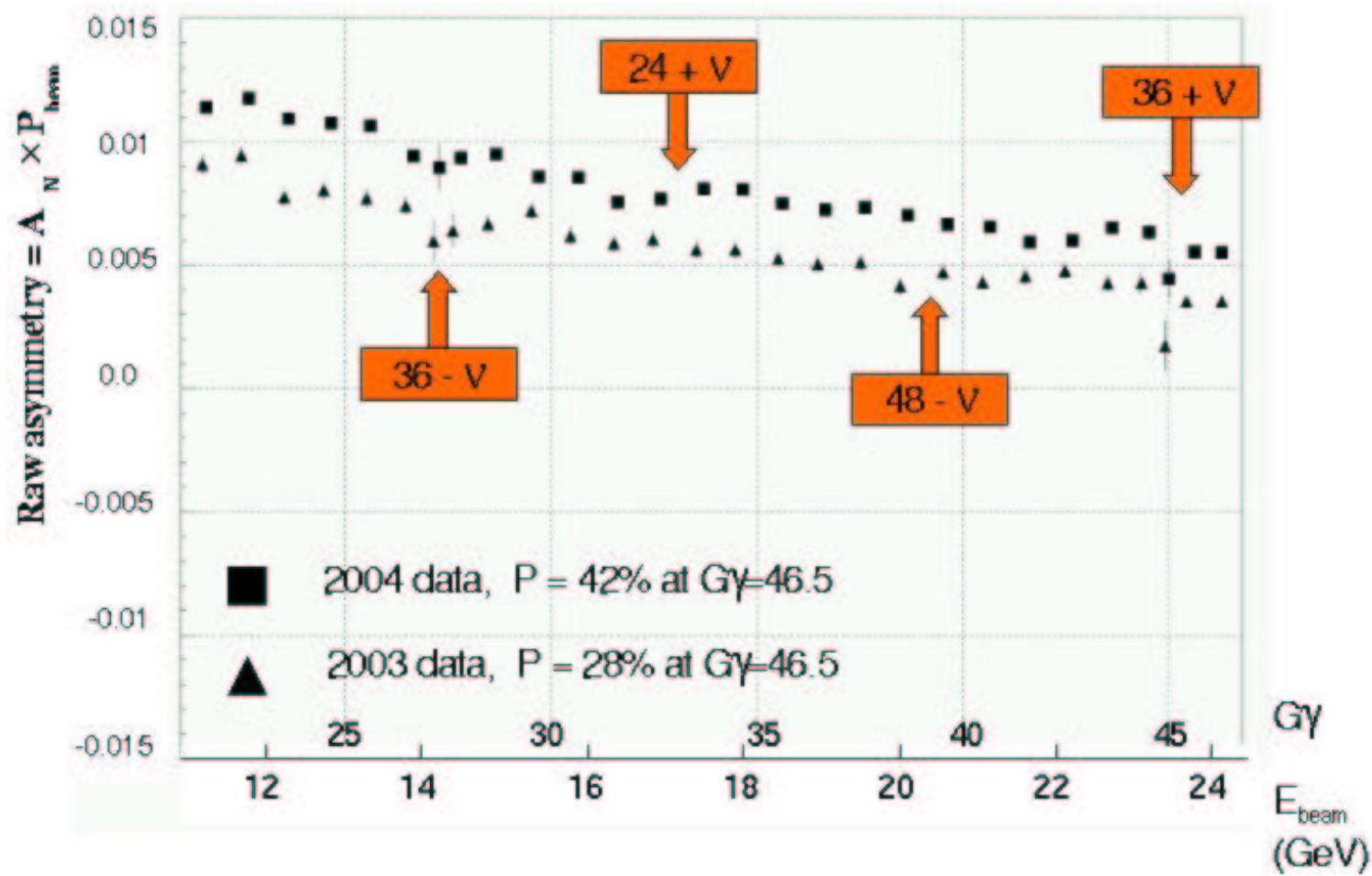


- $B = 1.53\text{T}$
- smaller coupling than solenoid

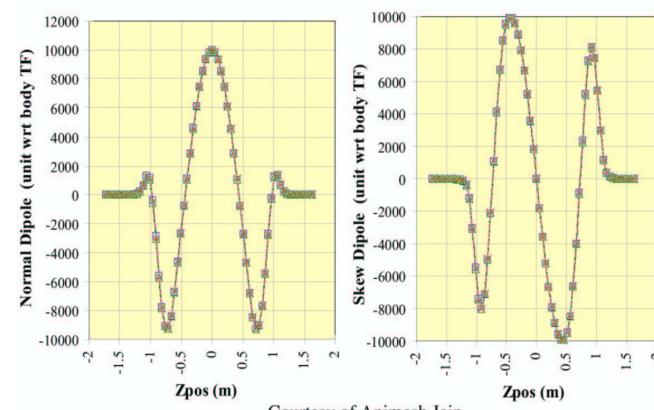
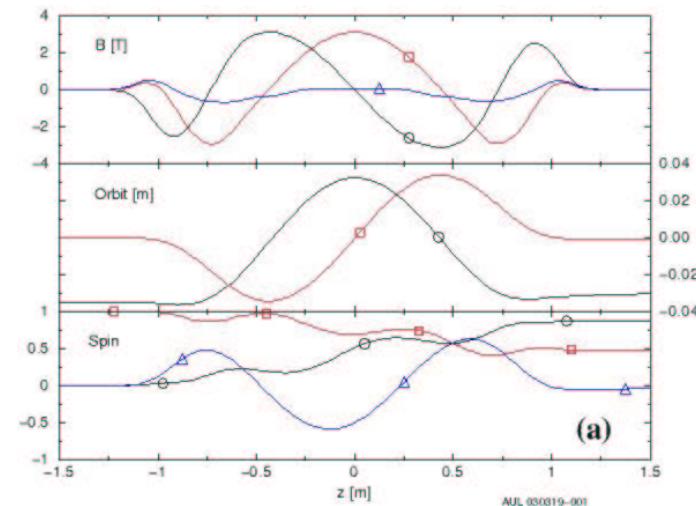
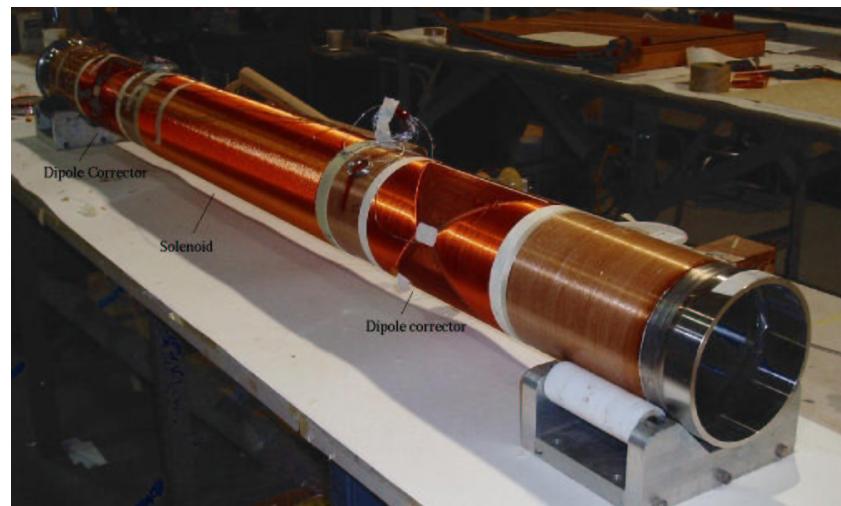
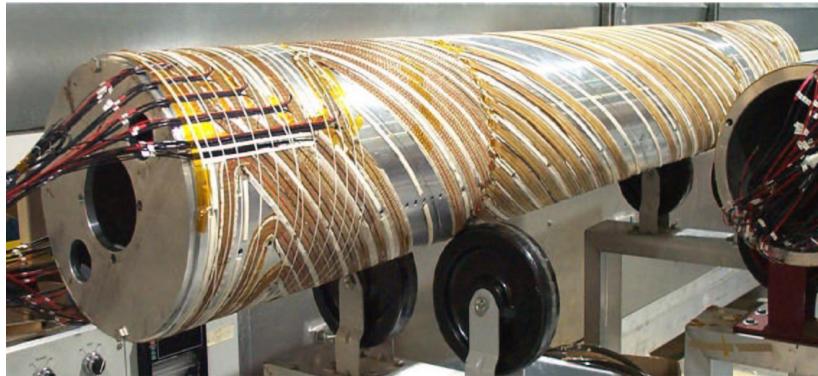
- Strength:
 - Inject: 8.3% ($\mu = 15^\circ$)
 - Extract: 5.9% ($\mu = 10.6^\circ$)

Provided by RIKEN; Designed by M. Okamura, J. Takano, and A. Luccio

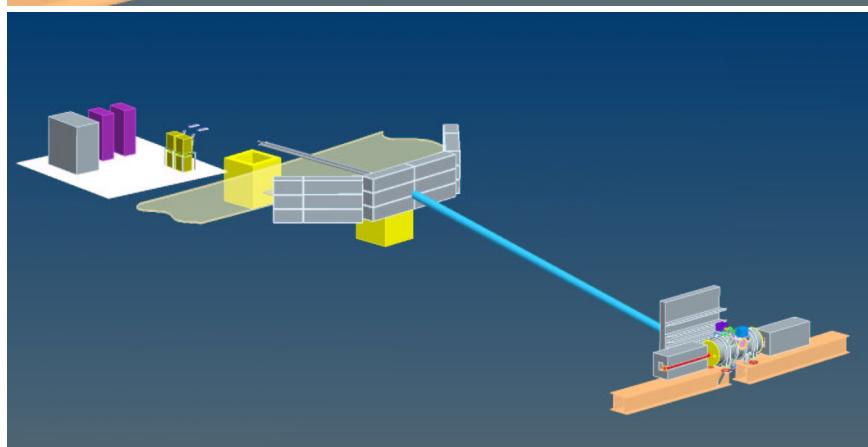
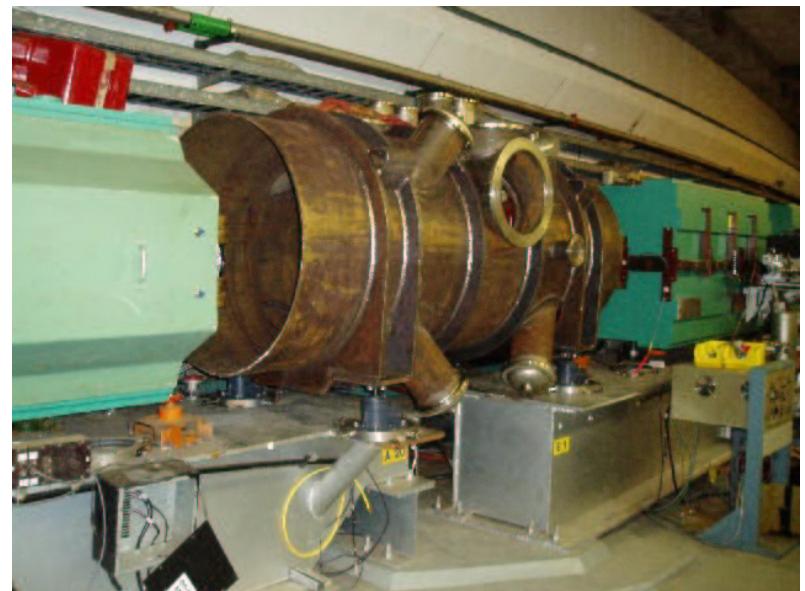
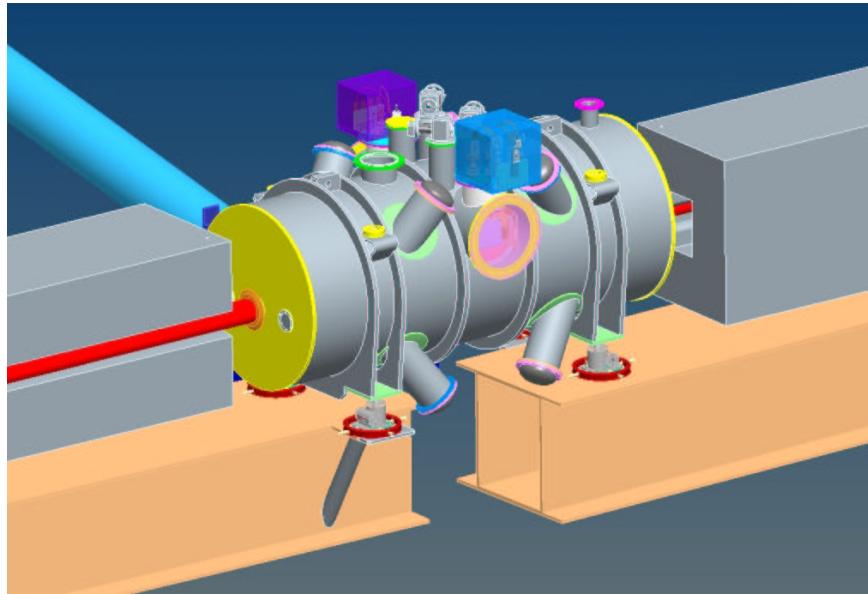
pC CNI Asymmetry during AGS Ramp



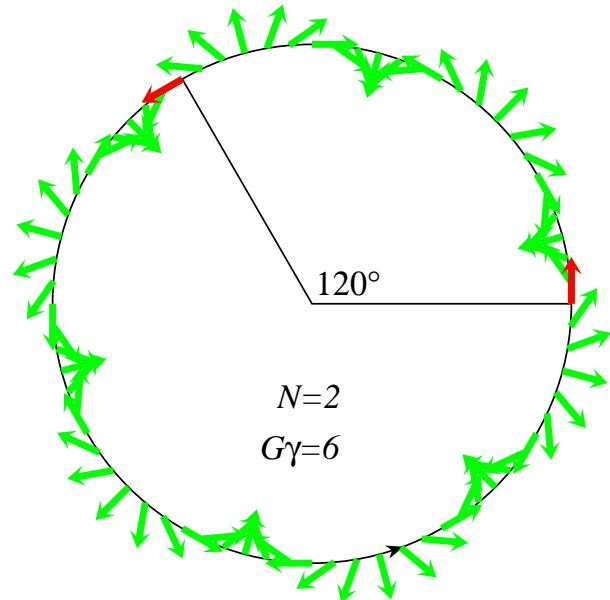
♪ New AGS cryogenic snake ♪



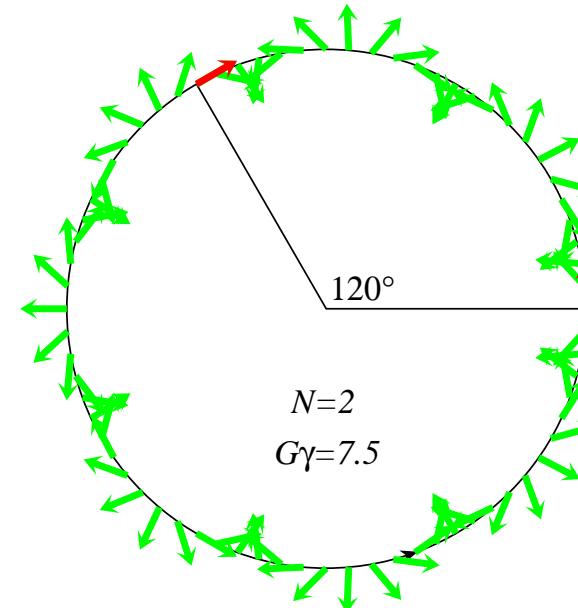
„Cold Snake Cryostat“



2 Partial Snakes spaced by 1/3 Ring



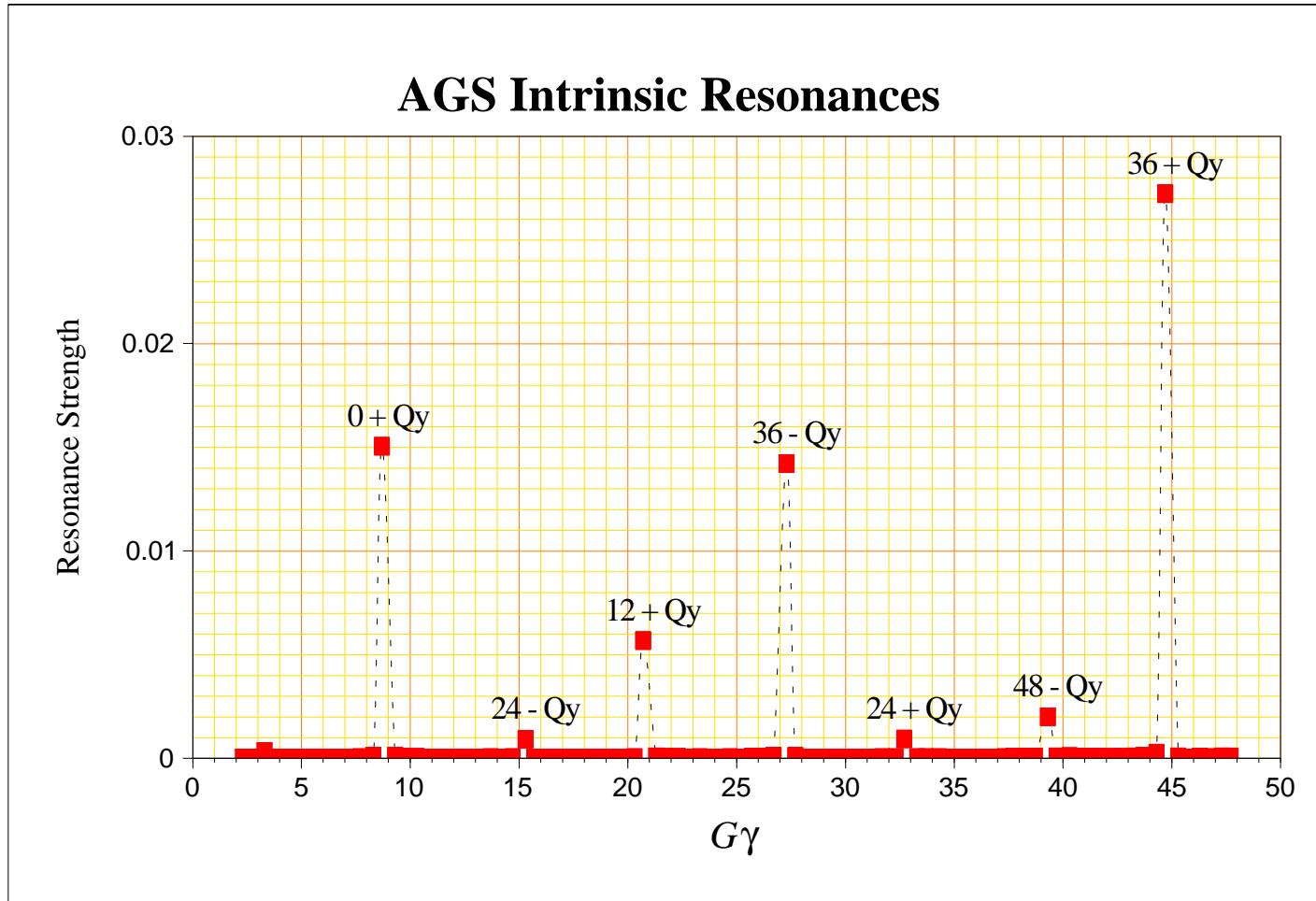
$G\gamma = 3 \times N$
Snakes strengths add.



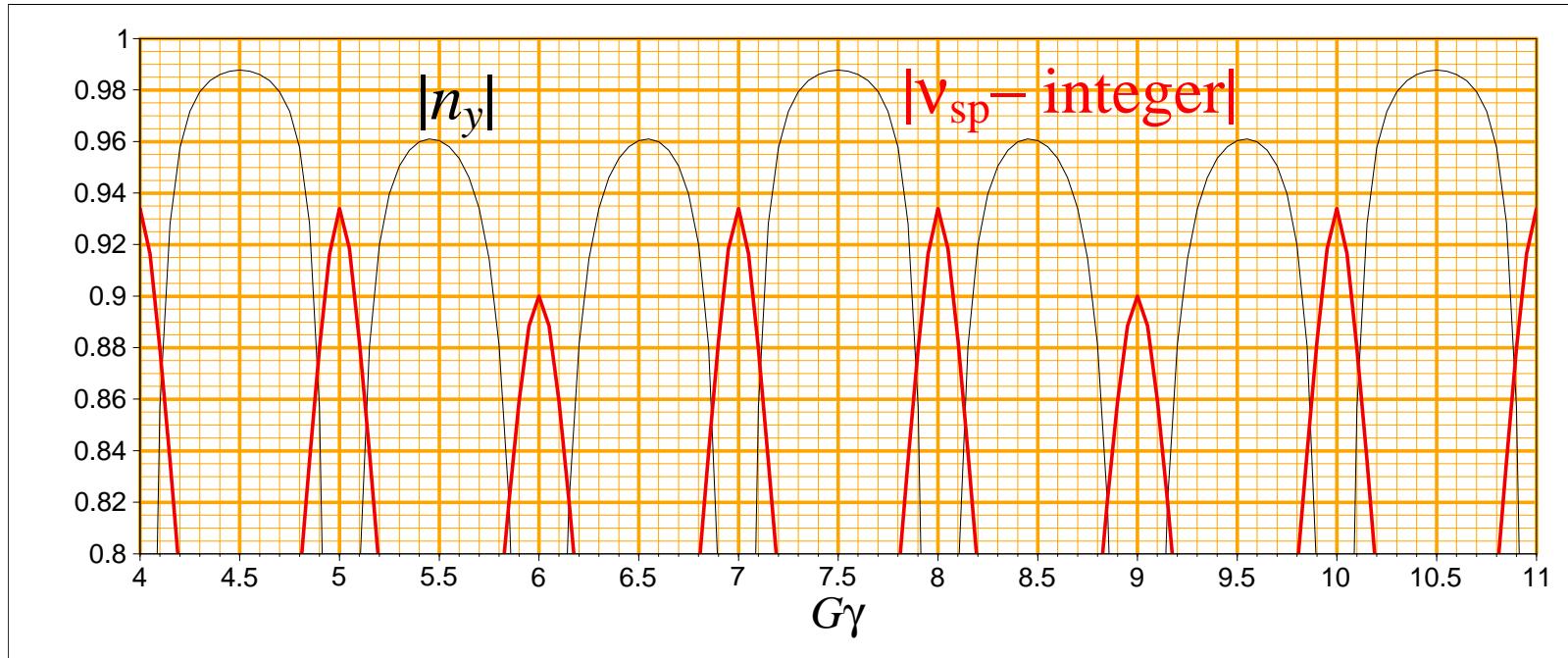
$G\gamma = 3 \times (N + 0.5)$
Snakes strengths subtract.

AGS has superperiodicity of 12.
Injection: $G\gamma = 4.5$ Extraction: $G\gamma = 46.5$

♪ AGS Intrinsic Resonances ♪



♪ Two Helical Partial Snakes in AGS ♪

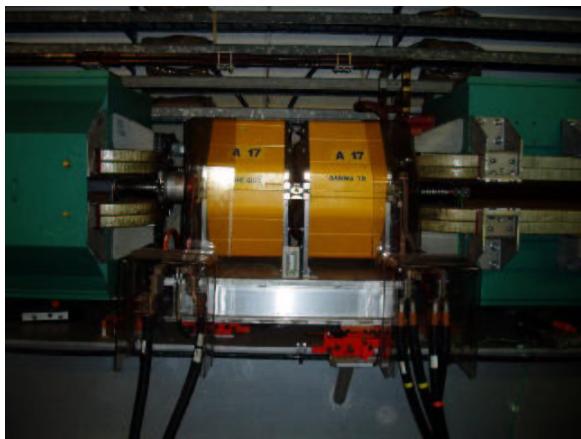
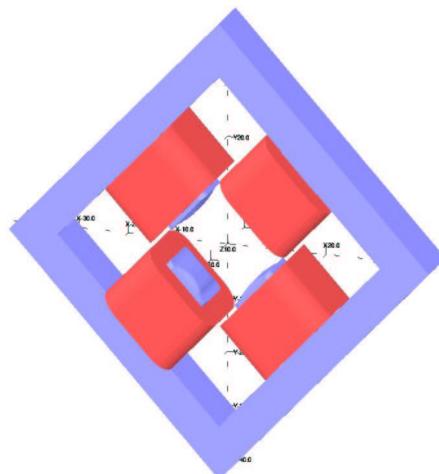


A20 Cold snake: 15%
E20 Warm snake: 5%
Superperiodicity: 12

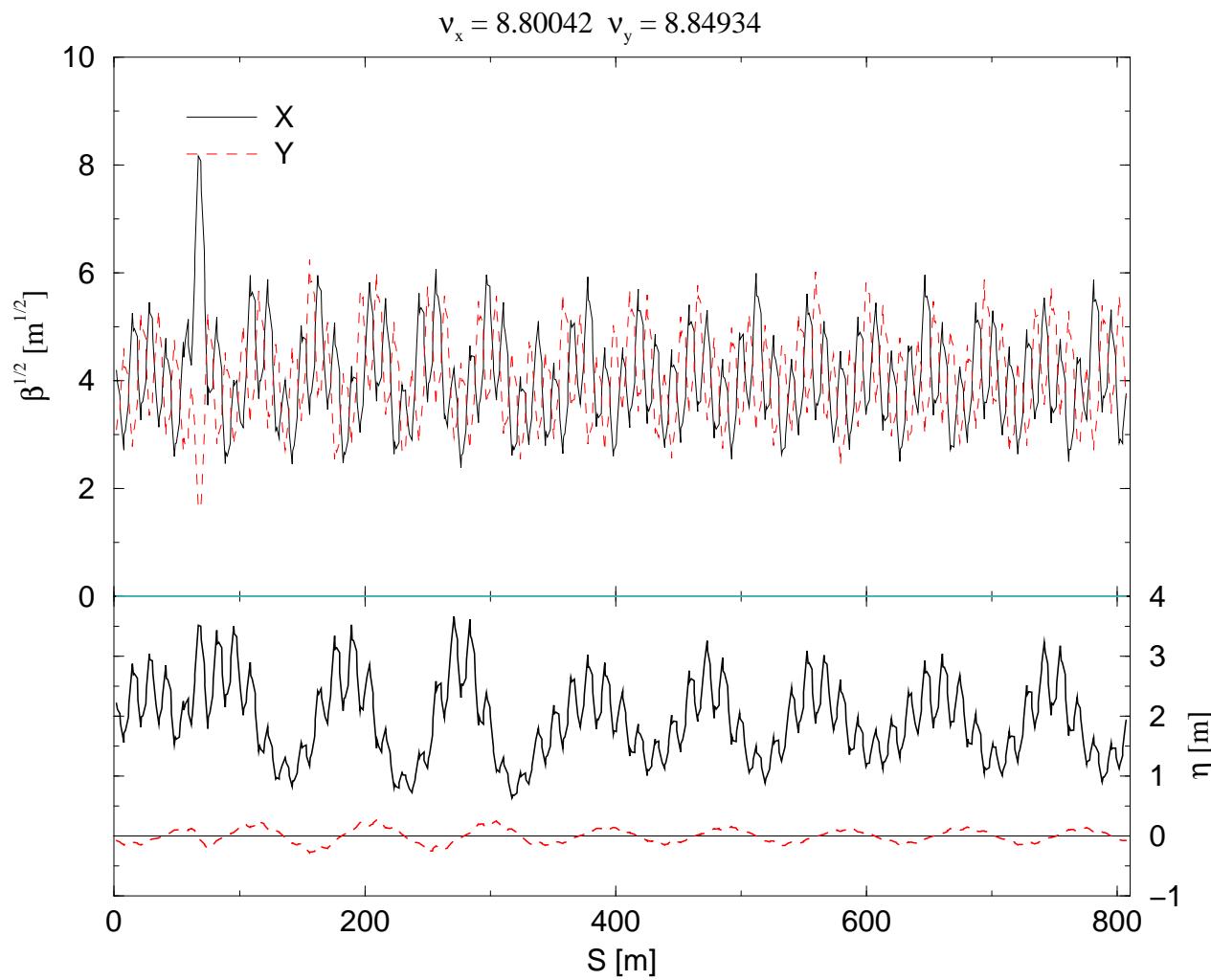
Spin tune stop bands: $\text{integer} \pm 0.065$
Putting $Q_y = 8.96$ eliminates intrinsic resonances.
Pattern repeats every 3 integers

Spin almost vertical at injection ($G\gamma = 4.5$) and extraction (46.5)

↳ New Correction Quadrupoles ↳



Two snakes 15% and 6.7% at injection



Cold snake:
A20

Warm snake:
E20

Extra Quads:
A17, A19,
B1, B3

Courtesy of
Mei Bai

Optics correction with 2 Quads

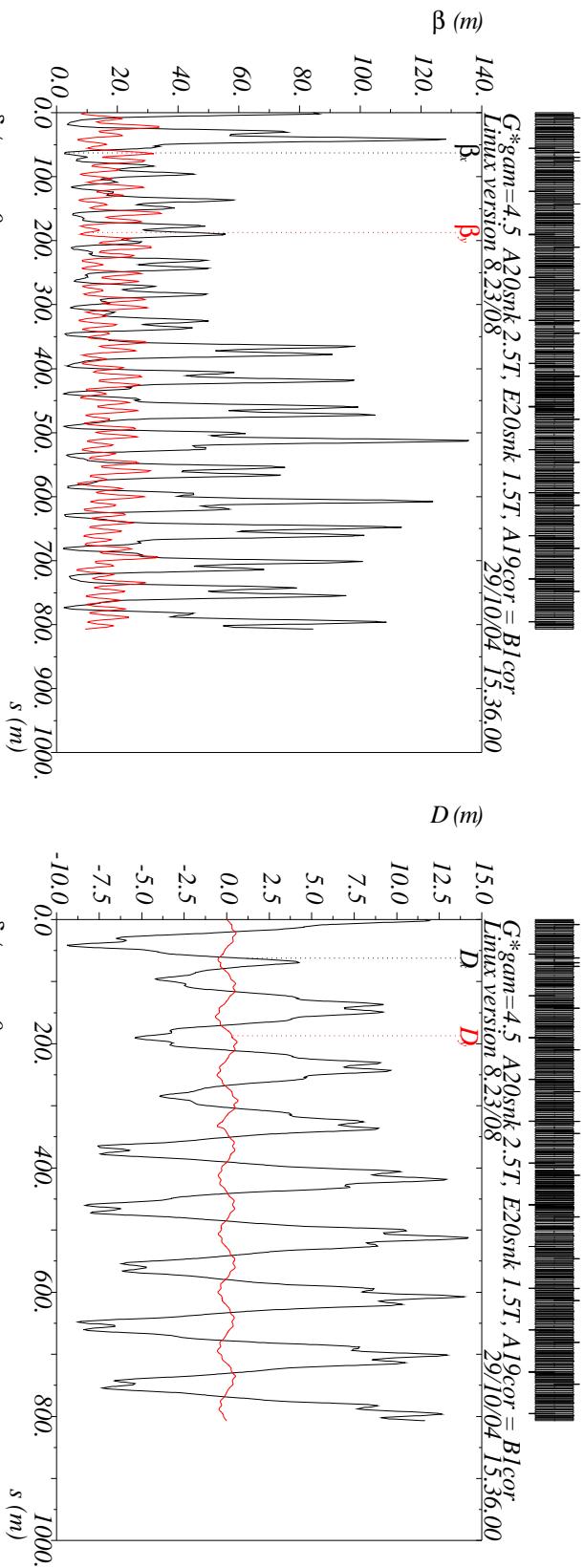
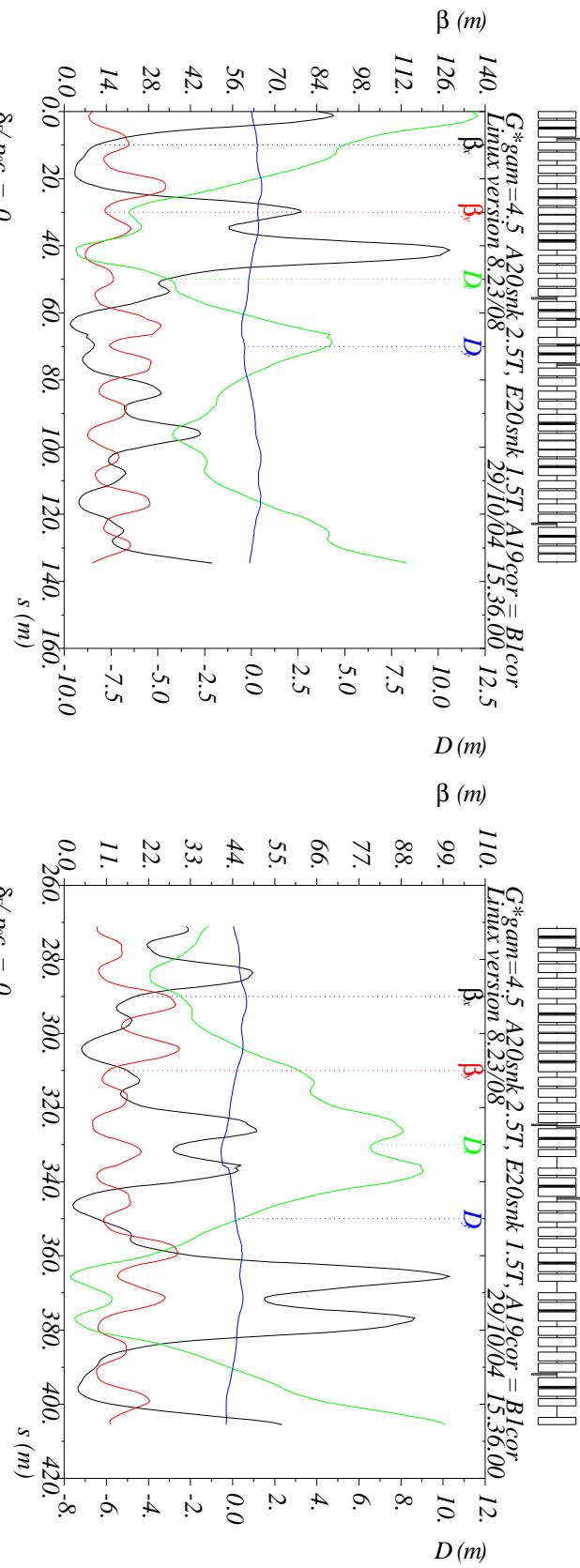


Table name = TWISS
 $\delta_{\text{rf}}/\text{poc} = 0$.

Injection tunes: ($G\gamma = 4.5$)

- $Q_x = 8.717$
- $Q_y = 8.743$

Optics correction with 2 Quads



$\delta_{\text{rf}}/p_{\text{oc}} = 0.$

Table name = TWISS

§ Schedule §

- Cryostat complete: End of December
- Testing in 902: 3–4 weeks
 - warm tests
 - quench tests
 - magnetic measurements
 - head load and cryocooler performance
- Install in AGS: End of January
 - Put in ring
 - Finish connections during maintenance days (over next 2 or 3 weeks)
- Cool down
 - Check connections during maintenance
 - Turn on supplies (1st time) during maintenance

Commissioning Plan

Commissioning will occur during RHIC stores with polarized protons.

- Initial conditions:
 - Start with new copy of “AGS User” for single warm snake.
 - Turn off ac dipole pulses on this “User”.
 - Use single small bunches ($\lesssim 10^9$ protons).
 - Inject individual bunches on demand only.
 - Turn on J10 extraction bumps on injection porch to prevent losses up ramp (rf loops might fail).
- Set up injection with two snakes.
 - Turn cold snake on in steps with bumps and quad corrections. Measure orbits and correct.

With injection working at desired snake strength:

- Increase bunch intensity to $\sim 7 \times 10^{10}$.
 - Measure injected polarization.
 - Turn off J10 dump bumps and accelerate the beam.
 - Adjust tunes up ramp: $Q_y = 8.96$ at $G\gamma = 7.5$ and above.
 - Measure polarization at top energy.
 - Tune up extraction.
 - Increase intensity — goal: 2×10^{11} per bunch at extraction.
-

- Starting tracking studies with 2-quad lattice.